User's Manual for SCRITS, SCReening Analysis for ITS

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Users Manual for SCRITS, SCReening Analysis for ITS

Purpose and Uses of SCRITS

SCRITS (SCReening for ITS) is a spreadsheet analysis tool for estimating the user benefits of Intelligent Transportation Systems (ITS). It is intended as a sketch-level or screening-level analysis tool for allowing practitioners to obtain an initial indication of the possible benefits of various ITS applications. It is not intended for detailed analysis. For situations requiring greater accuracy, practitioners may wish to use more sophisticated tools such as simulation models or the IDAS analysis tool being developed for FHWA.

SCRITS was developed in response to the need for simplified estimates in the early stages of ITS-related planning, in the context of a either a focused ITS analysis, a corridor/subarea transportation study, or regional planning analysis. SCRITS was developed based on the following principles:

- The analysis results should be compatible with transportation analyses conducted using other types of tools, such as travel demand models or simulation applications. For this reason, a number of the analyses in SCRITS require the user to provide baseline data from other local sources. For example, an analyst may use the output from a regional travel demand model (e.g. vehicle miles of travel and vehicle hours of travel) as input to SCRITS. Analyses of various ITS applications can then be conducted that “pivot” off these VMT and/or VHT values to estimate differences that would occur in VMT and/or VHT if those ITS applications were employed. This approach ensures that the results will be comparable to other analysis methods that are possibly being used in corridor/subarea or regional studies using the same travel demand model. However, some of the ITS applications require independent estimates of changes in VMT, VHT, or other statistics.
- The analysis should be adaptable to regional, corridor, facility, and subarea scales. Some analysts may desire planning-level estimates that cover the entire region. Others may wish to focus on an individual facility. SCRITS has been designed with flexibility for the user to specify the geographic/facility coverage, but the analyst must provide the baseline data consistent with the areas/facilities being analyzed.
- The analysis should produce estimates of benefit on a daily basis. These estimates should be expandable to an annual basis to enable calculations of economic benefit and comparisons to cost. SCRITS is therefore designed around daily analyses. Peak hour or peak period analyses are limited to ramp metering, which is targeted mainly to those periods.
- The analyst must recognize that there is a great deal of uncertainty regarding the effects of ITS applications. For example, few regions have good data on average duration of traffic incidents or the amount of delay caused by those incidents. In addition, little is known about the degree to which incident management strategies impact the duration of incidents or motorists’ choices to change their mode, route, or trip timing. Although information is improving, many assumptions are required to conduct analysis of ITS applications. Even more sophisticated methods will be subject to many of these same uncertainties. This is why

users of SCRITS should strongly consider conducting sensitivity analyses to a range of input assumptions.

Some of the primary applications of SCRITS may include the following:

- Approximation of user benefits for the evaluation of transportation alternatives in corridor/subarea studies, regional planning studies, other types of transportation studies
- Approximation of user benefits for ITS strategic planning
- Sensitivity analysis of the benefits of ITS applications to certain input assumptions

SCRITS does not include an evaluation of every possible ITS application. Rather, 16 different applications are identified for inclusion in the spreadsheet. These were selected based on a prioritization of analysis needs and an assessment of information available to use as the basis for analysis. In some cases, the tool requires input that may be best generated by another analysis procedure that is not contained in this tool. References are provided to other types of tools that relate to SCRITS, where appropriate.

Background

One of the reasons that the analysis of ITS applications has been so difficult, is that many ITS applications represent complex interactions between operating systems and traveler behavior. ITS applications are different from many traditional transportation strategies (particularly capacity-enhancement strategies) in that they are <u>operated</u>, not merely implemented and fixed forever. Many ITS applications assimilate information and present it to the traveler so that the traveler can make choices. The travel market that receives the information is often not well understood, and the traveler response to that information is even less understood.

The analysis of some of these ITS applications can require quite a number of assumptions. Even the amount of incident-related delay (or non-recurring delay) has been a matter of considerable debate, and it is this non-recurring delay that is targeted by a number of the ITS applications. There are many variables that affect the amount of non-recurring delay on any particular transportation system or facility, and the benefit of ITS applications varies depending on the amount of non-recurring delay that exists. The amount of non-recurring delay is affected by the frequencies of incidents, their location, severity, time of occurrence, etc. Traffic volume conditions vary extensively among urban areas and among individual facilities as well.

Because of the uncertainties in non-recurring delay (as well as recurring delay to some extent), and because of the numerous assumptions required in making a reasonable assessment of ITS benefits, SCRITS produces, at best, a general approximation of benefits. Possibly one of the best applications of SCRITS is testing the sensitivity of benefits to a series of assumptions, allowing practitioners and decision-makers to formulate options and alternatives that consider a range of possible results. For this reason, SCRITS provides a great deal of flexibility for the analyst to provide his or her own assumptions that are tailored to a specific set of conditions. One of the main advantages of SCRITS is the identification of the variables that can have an influence on the benefits and the overall structuring of the analysis. But there is substantial burden on the user of SCRITS to supply information that is appropriate for the conditions. In addition, those who examine and interpret the results of analysis from SCRITS should recognize that **the answers are approximate and should be used for general planning purposes only**. The tool is intended to be a "first cut" at the estimation of benefits for planning-level evaluation. Other tools should be used where more thorough analyses are required.

In keeping with the idea that the estimates are approximate, SCRITS is structured for application only on a daily basis, not for individual peak periods or peak hours. Users of this spreadsheet can adapt SCRITS to peak hour and peak period uses, if desired, but it was believed that the results would be nearly as approximate for the individual time periods as for the daily analysis. Therefore, a daily basis was used to retain as much simplicity as possible. The primary exception to this was the analysis of ramp metering, which is generally a peak period, peak direction strategy.

SCRITS requires users to supply a set of baseline data. This consists of study area definition and associated travel statistics or other parameters that are used in a variety of the ITS applications. For example, the user must define the area or facilities covered and supply an estimate of VMT for the study area. In addition, many of the applications require an estimate of the AWDT/C ratio (average weekday daily traffic divided by the hourly capacity). Recent research has developed relationships between the AWDT/C ratio and speed (so that recurring VHT can be estimated) and between AWDT/C ratio and non-recurring delay (so that non-recurring VHT can be estimated). However, users may input estimates of recurring and non-recurring VHT directly and make a choice between using the SCRITS-generated values or their own directly input values.

SCRITS is structured in "workbook" format. The baseline data are contained on a single worksheet of the workbook. The analysis of each individual ITS application is performed on a single worksheet within the same workbook. The analyses of each individual ITS application typically requires several items of user input plus data from the baseline worksheet. Several additional worksheets serve as lookup tables from which data are drawn to analyze the ITS applications. The primary measures of effectiveness calculated by SCRITS vary by individual application, but generally include the following:

- changes in VHT (for most applications)
- changes in VMT, where applicable
- changes in emissions (CO, NOx, HC), where applicable
- changes in vehicle operating costs, where applicable
- changes in energy consumption, where applicable
- changes in the number of accidents, where applicable
- economic benefit and benefit/cost ratio (for most applications)

Although the analyses are founded largely on weekday travel data (because this is what most transportation analyses focus on), calculations are also included to estimate benefits for the full week, where ITS applications are likely to provide benefit on weekend days. The user must provide all cost estimates (construction and operations/maintenance) and service life.

It is important to note that **SCRITS focuses on user benefits only**, not the benefits of ITS that accrue to agency operations (e.g. staff efficiency, management effectiveness, etc.). Often, these additional benefits constitute some of the main reasons for implementing ITS, and the benefits to the user may represent only a minor part of the total benefit. This would be true of some of the transit management applications, for example. Electronic fare collection may provide certain benefits to the transit rider, but the transit agency will benefit considerably from moving toward a system with less dependence on cash transactions.

Because the estimates of benefit are approximate, the spreadsheet does not analyze such things as induced traffic effects and other aspects that might be considered "finer details" of analysis of transportation strategies. SCRITS should be considered to provide order-of-magnitude estimates. Also, **the user may wish to adapt the spreadsheet to particular applications by adding additional features** such as other ITS applications, calculation of other performance measures, modification of formulas or lookup tables, etc. This spreadsheet provides a basic structure to the analysis, but users should feel free to modify it to fit their own needs. SCRITS has been kept relatively simple and straightforward to make these adaptations as easy as possible.

Users of SCRITS are cautioned against using it for applications for which it is not suited or ascribing to it more accuracy than it is intended to provide. This is important with any tool, but is particularly important with SCRITS, given the order-of-magnitude nature of its estimates. Considerable engineering/planning judgments are required, and this should be acknowledged when presenting results. SCRITS does not represent any Federally approved process or procedure. The user is responsible for the appropriate application of SCRITS and for ensuring that the input values and calculations are accurate and tailored to their application.

SCRITS was prepared in Microsoft Excel for Office 97. It uses the "comment" feature of Excel (not available in earlier versions) by which comments are provided for individual cells. These comments are a primary mechanism for documenting how the cell entry is calculated, how variables are defined, sources of the data in a cell, or other useful information. Conversion to other spreadsheet software or to earlier versions of Excel is not recommended.

To use the spreadsheet the analyst simply enters the required information (which is located in the column labeled "user input" – this column is also in red to distinguish it from the calculated column). Values that are calculated are contained in the "calculated" column. When the inputs have been finished and the calculations are complete, the results can be printed by individual worksheet or for the entire workbook. If individual worksheets are printed, it is recommended that at least the baseline worksheet be printed at the same time so that full documentation of the input values is provided.

For the most part, SCRITS is "self-documenting." Users of SCRITS can see the formulas and readily understand the data required and how the data are used in the various calculations. In addition, comments are provided on selected cells so that users can understand why the calculations are necessary or how the calculations are taking place. However, additional explanation is needed regarding certain elements of SCRITS, particularly the underlying approach for estimation of benefits for each of the 16 ITS applications. The remainder of this user manual describes the individual worksheets and the basic approach or philosophy in estimating user benefits for each of the applications. Comments on individual cells are provided in the spreadsheet itself.

Various sources of information may be useful to analysts in providing input values for SCRITS. The following sources are suggested for further information. However, there are still many gaps in the ITS data, and users of SCRITS will need to exercise considerable judgment in completing many of the analyses.

- The IDAS data library – a collection of ITS-related data useful for a range of analyses (obtain from FHWA Office of Research, ____________________)
- FHWA, *Estimating the Impacts of Urban Transportation Alternatives* (Publication No. FHWA-HI-94-053).
- FTA Office of Planning, *Technical Guidance on Section 5309 New Starts Criteria*, September, 1997.
- Mitre Corporation, *Intelligent Transportation Infrastructure Benefits: Expected and Experienced,* prepared for FHWA, publication no. FHWA-JPO-96-008, January, 1996.
- Smith, S.A. and D.B. Register, *Integrating Intelligent Transportation Systems within the Transportation Planning Process*, prepared for FHWA, January, 1998.
- Margiotta, R. and H. Cohen, "Development and Application of QSIM for Studying Incident-Related Traffic Flow Impacts," prepared for FHWA August 28, 1998.
- Ball Systems Engineering Division, *A Methodology for Measurement and Reporting of Incidents and the Prediction of Incident Impacts on Freeways,* prepared for FHWA, April, 1995.
- Cost document for the National ITS Architecture CD-ROM

Baseline Worksheet and Lookup Table Worksheets

The purpose of the baseline worksheet is to allow the user to provide descriptive information on the study area/facilities being analyzed, travel characteristics within that study area, and basic factors to be used elsewhere in the analysis. The following bullets comment on some of the primary features of the baseline worksheet.

- The study area can be defined in any way that the analyst desires: an entire region, a corridor, an area, a facility, or set of facilities. However, the input data needs to be consistent with the defined study area.
- The AWDT/C ratio is an important input value, from which speeds are estimated for the calculation of recurring VHT and incident-related (non-recurring) VHT. If values of VHT (recurring and non-recurring) are provided directly by the analyst, the AWDT/C ratios are not needed. The relationship between AWDT/C ratio and daily average speed is reflected in the FwySpeed and ArtSpeed worksheets, and is taken from tables contained in the FHWA/National Highway Institute training course "Estimating the Impacts of Urban Transportation Alternatives" (Publication No. FHWA-HI-94-053). The relationship between AWDT/C ratio and non-recurring VHT is drawn from the research conducted by Margiotta and Cohen, as documented in "Development and Application of QSIM for Studying

Incident-Related Traffic Flow Impacts," prepared for FHWA August 28, 1998. A ratio of non-recurring VHT to recurring VHT is extracted from the "inc_pct" lookup table, based on the AWDT/C ratio. This ratio is multiplied by the estimate of recurring VHT (either the user input value or calculated value) to derive the non-recurring VHT. The research with QSIM indicated that the presence or absence of shoulders is a major determining factor in the amount of non-recurring delay for specific facility types. Therefore the estimate of the percentage of study area freeways with shoulders is an important input to the estimation of non-recurring VHT. The calculation uses the fraction of freeway with shoulders in the calculation of a weighted average of the ratio between non-recurring and recurring VHT. The speed calculations in the baseline worksheet and the associated estimates of VHT are used extensively throughout the workbook.

- The "emis_fac" lookup table contains estimates of grams per mile for three pollutants (CO, NOx, and HC), vehicle operating costs per mile, and fuel consumption per mile. An emission factor or operating cost factor is provided for each 5-mile increment of speed. For those worksheets where emissions and operating cost values are used, the calculations are conducted by entering the lookup table with a speed value and interpolating the emission factors associated with the nearest two speed values.

Closed Circuit TV (CCTV)

The primary benefit of CCTV estimated within SCRITS is the reduction in average incident duration that may result by having the capability of visual observation of the incident scene and surrounding areas. Response agencies will be better equipped to send the proper response vehicles and to route them in a way that it most expeditious. Thus, the benefits are estimated by calculating the impact on non-recurring VHT of reducing the average incident duration. The analyst must estimate the number of minutes reduction in average incident duration. This reduction is multiplied by the estimate of non-recurring VHT in the baseline worksheet and factored by the percentage of study area freeways for which CCTV coverage is added. Unfortunately, little is known about the actual impact of CCTV on average incident duration. This is the most critical assumption in the calculations, and sensitivity analysis may be warranted. CCTV also has substantial benefits to agency operations that cannot be readily quantified, such as reduction in resources deployed for false alarms.

Cost estimates must be provided by the user if benefit/cost ratios and net present values are to be calculated. Cost estimates may be derived from the cost document on the CD-ROM for the National ITS Architecture, or from other sources available to the analyst. The analyst will also need to make a judgment concerning how certain cost elements are allocated among the ITS applications. For example, a portion of the communications system and traffic operations center may be allocated as a cost to the CCTV application, and portions allocated to other applications as well.

Detection

The Detection worksheet is oriented to the benefits from the placement of inductive loops or other detection devices on a freeway, to enable the operators to gauge the real-time characteristics of traffic flow. This worksheet does not include the dissemination of information on traffic conditions to the traveling public. That is covered in other worksheets. Rather, the focus is on the benefits to the identification and response to incidents or to unusual traffic flow circumstances. Therefore, the main benefit of detection, as defined here, is the potential reduction in incident duration. In this respect, it is very similar to the CCTV worksheet. The analyst must supply an estimate of the reduction in average incident duration and the percentage of freeway being covered with detection devices. It is assumed that the coverage is typical of most freeway systems (e.g. detectors at half mile intervals).

Highway Advisory Radio (HAR)

There are several worksheets within SCRITS that are designed to analyze various outlets for real-time traveler information. Some involve addressing traffic that is already on the road (en-route information), while others involve pre-trip information. In the case of HAR, the primary effect would be for motorists to alter their route so as to avoid congestion. Therefore, assumptions are required regarding how much time a motorist might be able to save, on average, if the route were to be altered. This average applies to all incidents for which the HAR may be activated. In many agencies, the HAR system would be used only for major incidents. Other agencies may make more frequent use of HAR. The worksheet places a substantial burden on the analyst to supply information about the use of HAR that is consistent with the agency's current operational philosophy or anticipated operation. One of the required assumptions is the frequency with which the HAR is actually used, which may vary by each agency's operating practice. The range in these assumptions could be broad, and sensitivity analysis would likely be warranted.

In addition, only a certain percentage of motorists will tune to the HAR broadcast, and only a certain percentage of those will be making trips that could benefit from diverting to another route. The propensity to tune to the broadcast and to take a diversion route will depend substantially on the specific conditions surrounding individual incidents. SCRITS asks the analyst for an estimate for the average or typical condition, not for a single event. Although diversion could decrease VHT, it could also increase VMT. Because of this, it is difficult to make estimates of the impacts on emissions and vehicle operating costs. Therefore, emissions and vehicle operating cost estimates are omitted from most traveler information strategies such as HAR.

Variable Message Signs (or Dynamic Message Signs)

Variable Message Signs are similar to HAR in that they provide information to motorists who are already in the process of traveling. Thus, the approach is similar to HAR, in that the analyst must make estimates of the percentage of drivers who may benefit from diversion and how much time they may save each time they divert. Little is known about motorist response to VMSs, because it varies widely according to the situation surrounding each application (severity of the congestion, availability of alternate routes, agency policy for using the VMS, etc.).

Pager-Based Systems

The idea behind pager-based systems (or other forms of real-time traffic information transmission directly to the vehicle) is to allow motorists to make informed route choices. If the system is a personal system (i.e. accompanies the person rather than just being in the vehicle), there is the possibility of making optimum route choices even prior to departing. The focus of this worksheet is on the time that can be saved through diversion by those who have access to the system. Although a personal system would allow travelers to also modify their start time for the trip, this is not directly accommodated. However, it can be indirectly accommodated by assuming that these individuals would also save time, just as those receiving en-route information may save time. The market penetration of the pager systems or other devices is a major factor in total effectiveness for the transportation system.

Kiosks

Kiosks assume that travelers will check traffic information on their way out to their vehicle and will take that information into account in selecting their route. The approach is similar to pager-based systems in that kiosks will only address specific portions of the travel market (i.e. those who have access to the kiosks, such as at major employment sites). In addition, only a certain percentage will actually look at the information, and only a certain percentage of those have the likelihood of saving time.

CVO Kiosks

This ITS application is targeted specifically to the Commercial Vehicle Operations (CVO) industry. It is included as a separate worksheet from the Kiosk worksheet to accommodate the specific values of time associated with trucks. However, it is similar to the Kiosk worksheet.

Traffic Information through the Internet

A common ITS application is to make real-time traffic information available on the Internet. This would be available to travelers wherever they have access to the Internet, mainly assumed to be home and work. Typically, a real-time display of traffic conditions would be available, and travelers would check the display just prior to leaving home or office. The effectiveness of the dissemination of information through the internet is largely dependent on the percentage of travelers who would be inclined to check the information before they leave and the likelihood of their being able to save time through diversion. The ability to change the timing of their trip also exists. This is not directly accounted for, since SCRITS uses daily analysis, but can be indirectly accounted for by assuming a time savings associated with altering their departure time. Little is known about how much time is actually saved by most travelers through diversion.

Automatic Vehicle Location (AVL) System for Buses

There are several reasons why an agency may wish to implement a bus AVL system. Some of the major reasons have to do with internal operating efficiencies. The primary benefit to bus riders would be the convenience and potential time savings of knowing when buses were arriving at their stops. Individuals could thereby reduce their waiting time at the bus stop. This reduction in waiting time is the primary benefit analyzed in the BusAVL worksheet. It assumes that the information on bus location is available to the transit rider through a medium such as cable TV or the internet.

The primary variables involved in the analysis include estimates of average wait times with and without the AVL system, the average number of passengers on weekdays and for the full week, and the percentage of passengers that actually use the information.

Electronic Fare Collection for Buses

Electronic fare collection is another ITS application that has substantial benefits to internal agency operation, perhaps even more so than benefits to the passengers. Internally, it reduces the handling of cash and provides more automation to the accounting system. The major benefit to passengers is the potential for speeding up the boarding process, thereby increasing the average bus speed. It is assumed that the potential increase in speed, over time, would be reflected in the bus schedule. The analysis requires the user to estimate the percentage of trip time associated with the boarding function, the processing time for conventional and electronic fares, and the percentage of fares that are assumed to be electronic. Estimation of benefits requires the estimation of daily passengers and average trip length per passenger. Finally, an estimation of change in transit ridership can be derived through an elasticity value relating the percentage increase in bus speed to the percentage increase in transit ridership. The increase in transit ridership is used to estimate a percentage decrease in vehicle trips. Because the percentage decrease in vehicle trips is likely to be small, and any change in traffic speeds or emissions inconsequential, those benefits are not included in the economic calculations.

Signal Priority Systems for Buses

The analysis of signal priority for buses includes two major elements: time savings for buses that are given priority, and additional delay for side street traffic. These interactions are very complex, and more detailed planning for this ITS application should include simulation. SCRITS provides only an order-of-magnitude estimate.

Two of the most critical assumptions for bus priority include the estimate of the percentage of bus travel time attributable to signal delay and the percentage of that delay that can potentially be reduced through bus signal priority on the defined route or routes. Information on the number of buses per day on the priority route and the length of arterial equipped with priority systems is also required. This, along with estimates of passengers and passenger trip length, enables an estimate of the potential reduction in person hours of travel. An entry for an elasticity value is provided, similar to the electronic fare worksheet, for estimating possible ridership increases and vehicle trip decreases, both of which will usually be small.

Electronic Toll Collection

Electronic toll collection is another ITS application that has substantial benefits for internal agency operation, allowing for reduction in manual toll collectors, more automated accounting systems, etc. The reduction in agency operating cost can be included in the cost calculations, if desired.

The analysis of electronic toll collection strategies is best conducted through a queuing model, which can account for changes in processing time as well as the resulting impact on vehicle delay. SCRITS provides an estimate of time savings attributable to processing time only. Changes in queuing delay are not included. It should be noted that changes in queuing delay will be affected by the extent to which the toll agency reduces the number of manual toll collectors.

The analysis requires the analyst to enter the daily toll volume and the percentage of vehicles by toll type for the case both with and without electronic toll collection. The processing time for each toll type is also required. The total processing time is simply the number of vehicles for each toll type times the processing time for each toll type. The difference between the total processing times with and without electronic toll collection represents the savings in vehicle hours.

Ramp Metering

Ramp metering is the only one of the analyzed strategies that is conducted on a peak period basis. This is because ramp metering is generally exercised only for peak period, peak direction travel. There are exceptions, and the analyst can adapt the spreadsheet to cover other situations. The basic structure of the analysis includes the assessment of changes in VHT for the three basic elements involved in metering: the freeway, the parallel arterial(s), and the metered ramps. SCRITS requires the analyst to input estimates of average speed with and without metering for both the freeway and arterial. The potential changes in speed are reasonably well documented from before-and-after evaluations of actual ramp metering systems. Little information exists on the effects of metering on parallel arterials. Ramp delay is estimated by multiplying a user-input average delay per vehicle at the ramp meter times the vehicle volume for the peak period. The total VHT savings is simply the difference between the estimated VHT with and without metering.

It should be noted that agencies vary in their operation of metering. Some are more aggressive in their metering strategy (i.e. have more restrictive metering rates), while others exercise metering on a more limited basis. The management of ramp queues is an important operational element to most agencies. There are quite a number of considerations in determining whether metering is an appropriate strategy for a particular area or facility. The analysis of potential user benefits is only one of those considerations, and should also be recognized as an approximation. Several simulation models are available for analyzing the possible benefits of ramp metering in greater detail (e.g. CORFLO, FREQ, and INTEGRATION).

Weigh in Motion

There are several variations of weigh in motion. The variation assumed in SCRITS is the ability to avoid weigh stations altogether as a result of mainline weight estimation. The same approach could be used for electronic credentialing. The benefits are calculated by estimating the delay avoided by not having to pass through the weigh station. The analysis does not include any calculation of queuing delay. This would have to be done separately using a queuing model. The value of time should be provided specifically as it applies to trucks.

Highway/Rail Grade Crossing Applications

Highway/rail grade crossing applications are the only ITS applications analyzed in SCRITS that include only safety benefits. The applications could include a variety of ITS strategies, ranging from applications that provide for constant warning times to applications involving in-vehicle warning systems. If an in-vehicle warning system is used, then the analyst is required to input a market penetration factor. If the warning system applies to all vehicles, then the market penetration should be set at 100 percent. Very little is known about the accident reduction effects of the various railroad grade crossing strategies, and the analyst will likely need to conduct sensitivity analyses to bound the possible benefit range.

Traffic Signalization Strategies

ITS applications of computerized traffic signalization can also cover a broad range, from fully centrally controlled systems to systems that use distributed control strategies. The approach to timing plan development and signal optimization varies. Some systems may include traffic responsive elements, while others rely mainly on multiple time-of-day timing plans. Some systems address the unique needs of special event centers, while others do not.

The benefit of signalization strategies extends well beyond simply the benefit to the motorist, depending on the system. Systems may include malfunction monitoring capabilities that immediately notify system operators of detector failures, need for bulb replacement, etc. This enables the operators to keep the system at an optimum level a greater percentage of the time and allows for efficiencies in system maintenance.

The analysis in SCRITS is founded on assumptions in average system speed with and without the ITS signalization application. The estimate of existing average system speed is drawn from the VMT and VHT data in the baseline worksheet. The user is required to input an estimated percentage increase in speed. Such estimates are available from signal system before-and-after evaluation studies. The Institute of Transportation Engineers' document *Strategies for Alleviating Traffic Congestion* provides a consolidated assessment of increases in average speed, based on the existing level of signal coordination and proposed level of signal coordination/system sophistication. The changes in VHT are calculated based on the VMT divided by the average speeds with and without the ITS improvements.

The Signals worksheet also accommodates the estimated change in the number of stops. It requires the user to estimate the number of stops per VMT and the percentage change in number of stops brought about by the system. Again, the ITE document *Strategies for Alleviating Traffic Congestion* provides data on typical changes in the number of stops. However, sensitivity testing is usually appropriate to bound the potential benefits. The change in the number of stops is included in the estimate of emission benefits by assuming the elimination of decel/accel cycles, each of which is assumed to generate a fixed quantity of emissions.

Combinations of Strategies

SCRITS does not directly accommodate calculations involving combinations of ITS strategies. Practitioners will need to determine this on a case-by-case basis. For some combinations of strategies, the benefits are mutually exclusive. For example, the benefits of arterial traffic signal improvements and CVO Kiosks can be added together, because they address different travel markets and geographic areas. On the other hand, traveler information strategies are not mutually exclusive. In some cases, coverage would be partially redundant, such as if HAR and VMS applications were applied for the same sections of freeway. Generally, agencies would not implement applications that overlapped to that degree. For cases where both area-wide and facility-specific information systems were being deployed, it is suggested that the market addressed by the facility-specific application would be reduced in proportion to the market penetration of area-wide strategy. Considerable judgment on a case-by-case basis will be required in the analysis of the effects of any overlapping strategies.

Summary

As stated in the introduction, SCRITS is intended as a useful tool for screening ITS strategies at a planning level. The user of SCRITS must make an assessment of its applicability to each situation and is encouraged to adapt and modify it to address the circumstances at hand. The structure of SCRITS has been kept simple to allow for easy adaptations to other situations. It should be considered as a starting point for analysis. Users may wish to extend the spreadsheet to peak period analysis, modify the lookup tables, add the calculation of other performance measures, or make a variety of other adaptations. By the use of SCRITS, the analyst is assuming full responsibility for its accuracy and appropriateness of application. FHWA welcomes comments on SCRITS, and may incorporate refinements into future updates. Comments should be provided to Mr. _______________ in the FHWA Office of __________________ . He can be reached at ________________ (phone) or ______________ (e-mail). SCRITS can be downloaded from the FHWA website at fhwa.dot.gov.